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SPENCE ON THE PROBLEM OF PATTERNING

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In a recent issue of this JOURNAL (8) Professor Spence has provided a long-awaited extension of his fruitful theory of discriminative learning (7) to the problem of stimulus patterning. After having been concerned for many years with the implications of a purely summative formulation, he has now turned his attention to data which clearly fall beyond the scope of the earlier theory. The occasion for the new statement was provided by an experiment on the relative difficulty of simultaneous and successive problems of discrimination (11), in the analysis of which Spence was led to consider the question of how the successive solution is achieved. A problem which requires the animal to turn to the left at the choice point of a T maze when both alleys are dark and to turn right when both alleys are bright should, in terms of a summative theory, be impossible of solution since there is no differential reinforcement in any afferent dimension.

The new formulation does not discard, but instead builds upon, the earlier summative principle, and the result is a three-level theory of perceptual development. I. In the "standard situation" (simultaneous) "the excitatory strength of the positive cue . . . becomes steadily greater than that of the negative cue" (8, p. 89) as a consequence of differential reinforcement. II. The solution of the successive problem, in which each afferent component is equally often reinforced, is dealt with in terms of the concept of *compounding*; in the T maze described above the compounds *dark-left* and *bright-right* "acquire excitatory tendencies to the response of approaching" (8, p. 90) while the compounds *dark-right* and *bright-left* do not. Such problems are more difficult to learn, and compounds will develop only "when no one of the cue members is systematically reinforced more than the others" (8, p. 90). III. A still higher level of perceptual organization—*transverse patterning*—appears in problems which "require that the animal on each trial respond or not respond (by approaching) to a particular figure depending on what the other figure [is]. . . . According to the theoretical view proposed here, response on the basis of such cue-cue relations . . . would take place in nonarticulate organisms, but only under conditions that would not permit learning on the basis of a single reinforced component or some simpler type of cue-position pattern (e.g., the type of patterning involved in the successive problem)" (8, p. 92). Spence thus proposes a hierarchical conception of perceptual development; each level appears in the context of a specifically defined problem, and higher-level organizations develop only when the conditions for the development of lower-level organizations are not met.

While this extension of the earlier theory, which brings it into closer correspondence with the realities of perceptual organization, may be welcomed as a step in the right direction, considerable evidence is available to suggest that it has not been carried far enough. The principal weakness of the new formulation is to be found in the restricted role which is assigned to what Spence has called "transverse patterning." In the most general sense this term refers to the effect of variation in the grouping or configuration of stimuli in a multiple-

choice discriminative problem (e.g., the arrangement of cards in a two-window jumping apparatus) when the reinforcement of specific components or compounds is equated. This grouping effect is not limited to the rather specialized kind of problem which Spence describes, which suggests that what the older summative formulation requires is not supplementation but a more thoroughgoing revision.

Transverse effects in "simultaneous" problems. In a recent experiment Saldanha and Bitterman (6) trained rats in the jumping apparatus to discriminate concurrently between two pairs of cards —two black-and-white vertically striped cards differing in stripe width and two homogeneous gray cards differing in brightness. For Group A the positive stripe was paired with the negative stripe and the positive gray with the negative gray (Problem A), while for Group B the positive stripe was paired with the negative gray and the positive gray with the negative stripe (Problem B). Although the differential reinforcement of afferent components in this Level I problem was the same for both groups, a transverse effect showed up clearly. The animals of Group A mastered Problem A and then Problem B before the majority of animals in Group B mastered Problem B. These results were accounted for in terms of the opportunity which was afforded by Problem A for comparison of the stimuli to be discriminated. Similar results have been obtained by Coate (1) in the context of a continuity experiment.

Still a third experiment on the effect of pairing was conducted by Elam and Bitterman (2). Rats were trained in a jumping apparatus to discriminate between black-and-white striped cards differing in thickness under conditions which provided experience with both horizontally and vertically striped cards. When the thickness discrimination had been mastered, the animals were trained to discriminate between horizontal and vertical stripes irrespective of thickness. For one group the two thin stripes and the two thick stripes were paired, while for a second group the cards were paired in such a way that a difference in thickness was present along with the difference in orientation (i.e., thick-vertical with thin-horizontal and thin-vertical with thick-horizontal). The relational presentation of *irrelevant* components *retarded* discrimination.

In a second series of experiments by Teas and Bitterman (9) and by Turbeville, Calvin, and Bitterman (10) further evidence of a grouping effect in Level I problems was obtained. These studies were designed to investigate what may be called the *two-situational* problem. Suppose that animals learn concurrently a discrimination between two vertically striped cards differing in thickness and between two gray cards differing in brightness. The stripes and grays are presented as pairs and the lateral arrangement of each pair is varied systematically. The problem thus presents *four* card arrangements to the animals—the two lateral arrangements of each pair. In the corresponding two-situational problem each pair is presented in only one lateral arrangement—e.g., light gray on the left and dark gray on the right, thick stripes on the left and thin stripes on the right—with the positive card of one pair on the left and the positive card of the second pair on the right. In both problems, therefore, one of the grays is consistently reinforced while the other is consistently punished, and each spatial component is randomly reinforced and punished. According to both the earlier and the later versions of Spence's theory the two problems should be functionally equivalent. The results show, however, that the two-situational problem is significantly easier than the four-situational problem and that there is little transfer from the first problem to the second.

These results demonstrate that, even in the context of a problem which provides differential reinforcement of afferent components, different levels of perceptual organization may emerge depending on the grouping of the stimuli.

A third series of investigations by MacCaslin, Wodinsky, and Bitterman (5) on the process of stimulus generalization bear on the problem of transverse patterning. In one of these experiments a group of animals was trained to discriminate between horizontally and vertically striped cards (vertical positive) and a second group was trained to discriminate between the vertically striped card (positive) and a black card. The groups were equated for number of reinforcements on the positive card and then trained to discriminate it from another vertically striped card (negative) differing in thickness. The performance of the first group was superior to that of the second, demonstrating that the context in which reinforcement is given determines to an important extent the nature of perceptual development. An analysis in terms of components leads to precisely the opposite prediction on the basis of the inhibition which should be generated from the horizontally striped card of the first problem. Similar results were obtained in other experiments of this series.

Transverse effects in successive problems. An experiment by Wodinsky and Bitterman (12) demonstrates grouping effects in a problem which is possible of solution on the basis of cue-position compounds alone. Animals were trained in a three-window jumping apparatus on a problem involving black, white, and vertically striped cards. One group was reinforced for jumping to one window when three black cards appeared, to a second window when three white cards appeared, and to the third window when three striped cards appeared (e.g., *B*BB, W*W*W, SS*S*, where the positive cards are italicized). For the second group the card-position relations were identical except that the cards were grouped differently (e.g., *B*SW, S*W*B, WB*S*). As each animal in each group reached criterion on its problem, it was shifted to the problem of the other group. According to Spence's latest formulation, the two problems, which involve identical compounds, should be functionally equivalent; arrangement should make no difference because the problems can be solved on the basis of compounding alone. The results, however, show a clear transverse effect. The first problem proved to be more difficult than the second and transfer from each problem to the other was quite incomplete (initial responses were about 60% correct as compared with a chance level of 33%).

Theoretical and experimental constriction. Although these experiments clearly demonstrate the operation of transverse effects in first- and second-level problems, it may be anticipated that Spence will not consider them relevant to his theoretical position. For one thing, the experiments were performed with the jumping apparatus which involves the use of punishment for errors, a condition which Spence has "specifically avoided" (8, p. 89). Furthermore, in some of the experiments the correction method of training was utilized, although Spence has concentrated upon results obtained with the noncorrection method. Finally, there is reason to expect that Spence may regard the experimental designs as too complex. In discounting the results of Weise and Bitterman he remarks, for example, that "it is difficult to interpret the very complex type of discrimination set-up they employed. The simple discrimination situation is sufficiently difficult to deal with theoretically without adding all of the problems that arise as the result of the serial nature of the multiple-discrimination set-up along with the fact that it involves a gradient

of reinforcement" (8, p. 91).[1] Similar reasons might be advanced for discounting the experiments here described.

Now it is easy enough to protect a restricted theory by the design of restricted experiments, and it is easy to emphasize the limitations of such a theory by the design of broader experiments. The fundamental problem concerns the relative value of the two approaches. As Leeper (4) has noted, it is possible to take the position that research under restricted conditions will at least reveal the fundamental processes at work under those conditions, although the principles thus derived may have to be supplemented when the scope of research is broadened. Leeper himself believes that the principles derived from research under restricted conditions are likely to be superficial. "Such research," he maintains, "is not conducive to the discovery, in any deep and significant sense, of the fundamental processes at work even within a limited area" (4, p. 489). It might be well if this position were given serious consideration.

At other points in Spence's presentation restrictions seem to be brushed aside and his principles seem to acquire a more general flavor. This tendency is especially evident when he denies that "the type of patterning that the Gestaltters and Gulliksen and Wolfle are talking about" may be evidenced in problems which can be mastered on the basis of differentially reinforced components or compounds (8, p. 92). It may be maintained on the basis of the evidence here reviewed that such effects do occur under certain experimental conditions. While the "complexity" variable is difficult to evaluate, the influence of the correction methods and punishment for errors should be studied in subsequent experiments. It may be anticipated that the results of such experiments will demonstrate the need for a more fundamental modification of Spence's theory than has yet been proposed.

[1] The experiment in question and the one by Spence provide the only comparisons of simultaneous and successive problems to be found in the literature. Spence should not have been "surprised" by the failure of Weise and Bitterman to consider Lawrence's data. Lawrence made no directly comparable studies of the two kinds of problem. Results identical with those of Weise and Bitterman (obtained with a modified jumping apparatus) will soon be published (M. E. Bitterman and Jerome Wodinsky, Simultaneous and successive discrimination, *Psychol. Rev.*, in press).

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